AN EVALUATION OF THE MAJOR QUALIFICATIONS DESIRED OF AIR FORCE SYSTEM PROGRAM MANAGERS

Ralph E. Smythe, et al

Air Force Institute of Technology
Wright-Patterson Air Force Base, Ohio

January 1975

The Air Force places a great deal of emphasis on the proper selection of system program managers for its multi-million dollar programs. There is an assumption that there is no difference in the desired qualifications of a system program manager over the program acquisition life cycle (conceptual, validation, full scale development, production, and deployment phases). This assumption is largely unsubstantiated in the literature. This study conducted an exploratory evaluation on the education, experience, and managerial trait qualifications desired of system program managers over the program life cycle. Interviews were conducted with the present system program managers of major Air Force programs to obtain data bearing on the relationship of the desired qualifications between the individual stages. The authors concluded from an analysis of the data that there is a difference in education and experience, but not of managerial trait qualifications desired of system program managers between the conceptual/validation phase and the full scale development/production/deployment phase. The research results showed that the primary difference lies in the fact that an engineering background (education and experience) is preferred in the initial stage of a program, but shifts to a management background (education and experience) in the latter stages.

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AN EVALUATION OF THE MAJOR QUALIFICATIONS DESIRED OF AIR FORCE SYSTEM PROGRAM MANAGERS

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

Ralph E. Smythe, BA
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January 1975

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This thesis, written by

Major Ralph E. Smythe

and

Captain William J. McMullan

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics ir partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT

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Stephen E Barndt

COMMITTEE CHAIRMAN

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CHAPTER I

INTRODUCTION

Statement of the Problem

Contemporary literature, in its study of the program manager's "modus operandi," has defined the manager's role (4:63), but contains very little information concerning the major qualifications in terms of, (1) experience, (2) education, and (3) managerial traits, desired of a program manager. Furthermore, what is found in the literature tends to reflect the possibility of a dynamic, changing nature of the problems facing the program manager as his program proceeds from its inception to completion (2:93).

The identification of the major qualifications desired of a program manager at various stages of the acquisition life cycle of a program would provide the basis for development of criteria to help in the selection of personnel to fill key program management positions.

Definition of Terms

Experience. Activity that includes training, observation of practice, and personal participation (12:83).

Education. The state of training and developing knowledge, skill, mind, and character (12:83).

Managerial traits (personality). Distinguishing qualities or characteristics, especially of personality (12:84).

Program. Equipment and/or skills together with any related facilities, services, information, and techniques, that form a complex or an entity capable of performing specific operational tasks in support of identifiable DoD objectives (23:2).

Program management. A concept for the technical and business management of particular systems/programs based on the use of a designated, centralized management authority who is responsible for planning, directing, and controlling the definition, development, and production of a system/program (23:2). Throughout this study, program management will be used synonomously to mean project management, matrix management, and system management unless otherwise indicated.

Program manager. The generic term used to denote the single Air Force manager (System Program Director, Program/Project Manager) during any specific phase of the acquisition life cycle (24:4).

Program management office. The organization comprised of technical and business management and administrative personnel assigned full time to a System/Program Manager. The office may be augmented with additional personnel from participating organizations (23:2).

Functional parity. A basis for determining the rank/grade structure, number and quality of personnel required for a System/Project Management Office (23:3).

Acquisition life cycle. Normally, consists of five phases (Conceptual, Validation, Full-Scale Development, Production, and Deployment) with three key decision points (Program, Ratification, and Production Decisions) between each of the first four phases (24:4).

Conceptual phase. The initial period when the technical, military, and economic bases for acquisition programs are established through comprehensive studies and experimental hardware development and evaluation (24:4).

Validation phase. The period when major program characteristics are refined through extensive study and analyses, hardware development, test, and evaluations (24:4).

Full-scale development phase. The period when the system/equipment and the principal items necessary for its support are designed, fabricated, tested, and evaluated (24:4).

Production phase. The period from production approval until the last system/equipment is delivered and accepted (24:4).

Deployment phase. The period beginning with the user's acceptance of the first operational unit and extending until the system is phased out of the inventory. It overlaps the production phase (24:4).

Concurrency. The overlapping of program phases, such as undertaking full scale development before the conceptual phase has been completed, or undertaking production before development is completed (21:12).

Program Management Directive (PMD). The official Hq USAF management directive used to provide direction to the implementing and participating commands and satisfy documentation requirements (24:4).

Program Management Plan (PMP). The document developed and issued by the Program Manager which shows the integrated timephased tasks and resources required to complete the task specified in the PMD (24:5).

Concept of Systems

The concept of systems is basic to this thesis, both in understanding the importance of the problem and in defining the terminology. Systems management is a term literally used and intuitively defined by many people. Nevertheless, it may be of value in assessing the scope of the program manager's responsibilities to define and point out some common characteristics of systems. Buffa (1:39),refers to a system as a "regularly interracting or interdependent group of items forming a unified whole."

Thus, a system may have many components and elements (materials, information, machines, people, etc.) which are united in striving toward some common goal. Applying the systems concept to design and development is widely accepted by the Department of Defense and its contractors. The systems concept is the concept of a group of components designed to serve intended purposes or missions (17:1). Complexities in viewing "systems" are easily envisioned (17:1). Consequently, it is of paramount importance to the Air Force that proper qualifications are determined for individuals heading up the major systems.

Importance of the Problem

The need for program management. The concept of program management and its subsequent implementation emerged primarily from the needs and problems of the Department of Defense and the National Aeronautics and Space Administration (26:1). Increased sophistication, complexity, and cost of new weapon systems has served to surface program management as a dynamic management system in the Air Force (14:61).

In an age when technology is increasing at a geometric rate, and resource dollars are becoming more and more scarce, the selection of program managers to meet the challenge of resource management is of crucial importance (6:34). In FY 1973 Air Force Systems Command

(AFSC) received 30% of the Air Force budget (27). As the heads of the principal organizations charged with bringing new weapon systems into being, program managers have the responsibility for efficient utilization of much of the command's resource dollars (13:31).

The advancement of technology in all phases of industrial management, and in particular, the military industrial complex since World War II has no precedent. Since radical changes occuring in the design and development strategies often do not fit the purely functional type of organization, attention is now being given to moulding the organization around the task.

> A program has a distinct life cycle, moving from concept formulation and definition to acquisition and operation. This cycle begins with a concept feasibility analysis, progresses through market definition and production, and ends when the project is obsolete or nonexistent in its intended environment [4:70].

It is important to distinguish between program management and traditional/functional management in order to understand the profound impact of the program management concept on a new management style for particular management situations.

Relationship between traditional/functional management and program management. Traditional/functional management functions mostly on a vertical basis, and depends almost exclusively on a strong inviolate superior-subordinate relationship to insure a unified effort (5:81).

However, the program manager crosses functional lines to bring together the management activities required to accomplish program objectives. The program manager's authority is a combination of "de jure" in the sense that it exists by rightful title, and "de facto," which is the intrinsic power to fully discharge responsibilities inherent in the task at hand (2:91).

Program management is compatible with the traditional/functional approach to management. The program manager requires full support from the functional organization to meet his program objectives and the functional manager needs the program requirements to meet functional and organizational goals (5:32). Program management has provided a way of thinking about management of highly technical and costly products whose development and acquisition is spread across several large autonomous organizations (13:70). In the total sense, program authority is comprised of both the legal and personal influence that the program manager exercises over the cost, schedule, and technical considerations of the program (5:84). Figure 1 compares the traditional/functional style of management with program management.

Of the many differences between traditional management and program management two that are particularly important to the program manager's role behavior are:

Phenomenon	Program	Functional
Line-staff organizational dichotomy	A web of authority and responsibility relationships exists.	Line functions have direct responsibility for accomplishing the objectives; the line commands, staff advises.
Scalar principle	Elements of the vertical chain exist, but prime emphasis is placed on horizontal and diagonal work flow.	The chain of authority relationships is from superior to subordinate throughout the organization.
Superior-subordinate relationship	Peer to peer, manager to technical expert, associate to associate relationships.	All important business is conducted through a pyramiding structure of superior-subordinates.
Organizational objectives	Management of a project becomes a joint venture of many relatively independent objectives.	Organizational objectives are sought by the parent unit working within its environment.
Unity of direction	The project manager manages across functional and organizational lines to accomplish common inter-organizational objective.	The general manager acts as the head for a group of activities having the same plan.
Time duration	The project is finite in duration.	Tends to perpetuate itself.
Parity of authority and responsibility	Considerable opportunity exists for the project manager's responsibility to exceed his authority.	The integrity of the superior-subordinate relationship is maintained throughout functional authority.

Figure 1. Functional Versus Program Viewpoints (4:66)

(1) the program manager's authority vastly exceeds any that could be delegated under the concept of functional authority, and (2) program authority unifies all organizational activities regardless of where they are functionally located (9:31).

The role of the program manager. To adequately analyze and evaluate the qualifications desired when selecting a program manager, it is necessary to be acquainted with the role of the program manager and its evolution.

Forerunners of the program manager, designated as "project expediters," did not perform line functions, but rather informally motivated those persons doing the work (5:18). Ranked slightly above the project expediter in terms of time and responsibility was the "project coordinator," who had a more formal role in the organization, and was concerned with the synchronization of organizational activities directed toward a specific objective in the overall functional activities (5:18). The project coordinator did not actively enter into the management function outside of his particular organization. (26:273).

Today's program manager is in every sense a manager; he actively participates in the organic functions of planning, organizing, directing, and controlling the organization of the specific program (2:91). He prepares

and issues a program management plan (PMP) in consonance with the program management directive (PMD) (24:2). According to Gemmil and Thamhain, the program manager accomplishes the management process through other managers. In this arrangement the program manager has authority over the functional managers with respect to the what and when of the program activities. Functional managers are in turn responsible to both their functional supervisors and the program manager for adequate support of the program (4:68).

The military program manager's role, then, is to tie together, to manage, to direct the development and production of a system meeting performance, schedule, and cost objectives which are defined by his Service and approved by the Secretary of Defense (SECDEF) (14:73). The essence of the program manager's role is to be the agent of the Service in the management of the System acquisition process, and to focus the authority and responsibility of the Service for operating the program. He has the vantage of an overall perspective of the program and the interrelationships among its elements. He must be the major motive force for propelling the system through its evolution (21:4). The breadth of the complexities faced by the program manager is highlighted by David L. Wilemon in his article, "Project Management and its Conflicts: A View from Apollo," (25:531) in which he described the characteristics of program

management systems as:

1. Problem orientation. Program management is used to solve specific, complex, identifiable problems.

2. Multidisciplinary focus. Program teams are composed of a range of expertise and serve as a vehicle for integrating the inputs of diverse specialists.

3. Systems perspective. The team must be cognizant of the internal workings of the program as well as the larger organizational environment of the project.

4. Horizontal/vertical organizational relationships. Program management is a system that must often operate both vertically and horizontally with its "host" organization.

5. Finite duration. Program organizations are established and maintained only until a task is completed. Once the program objectives have been achieved, the program team is disbanded.

6. Change oriented. Program groups must be flexible. Environments change, political influences change, budgets change, even the scope of problems changes.

7. Innovation in organizational design. Complex tasks often require one-of-a-kind organization structures.

8. Responsibility identification. Program management employs a deductive approach in breaking a task down into manageable components. Such a system aids in establishing a system of responsibility and accountability for each project task.

Program management in the Air Force. A fundamental Department of Defense (DoD) policy is that the acquisition of major weapon systems will be directed by responsible managers under the concept of program management (13:4). This fundamental policy underlies the priority and attention that program management is receiving as programs get larger and more sophisticated, and resources become in shorter and shorter supply (14:75).

The Air Force has over 100 weapon and support projects classified as major programs, which are managed by program managers with the grade of Lieutenant Colonel through Major General (14:6). The specific grade requirement is determined through a functional parity assessment of the task at hand. These Air Force program managers plan, organize, and control the development and acquisition of weaponry involving billions of dollars (5:81). Program managers are supported by subsystem managers and other program managers throughout the research, development and production complexes of governmental and industrial organizations. Within the Air Force structure, program managers are identified as symbols of leadership of their programs (5:86).

The Deputy Secretary of Defense issued a memorandum stating:

> The entire management problem needs to be addressed under these simple guidelines: put more capable people into program management, give them the responsibility and the authority and keep them there long enough to get the job done [14:7].

The report to the President by the Blue Ribbon Defense Panel stated:

> The effectiveness of program management would be improved by: developing selection and training criteria that will assure the availability of an adequate number of qualified officers. The criteria should emphasize achieving a balance between needs of a knowledge of operational requirements and experience in management; also providing authority commensurate with the assigned responsibility and more direct reporting lines for program managers [22:81].

In a memorandum entitled "Policy Guidance on Major Weapon System Acquisition", the Secretary of Defense said:

> Management in the services will be improved only to the extent that capable people with the right kind of experience and training are designated to manage these major programs. If capable people are going to be willing to undertake these important program management assignments, ways must be found to give them some incentive to do so. Program managers must be given more recognition toward career advancement in all of the services, and good managers must be rewarded as good operational people are rewarded [12:31-32].

Lt General Hudson, Vice Commander, Air Force Systems Command, recently stated that:

> The program manager is the key to program success. We at AFSC put a great deal of emphasis on selection of the right man for the program manager's job [14:55].

The above cited policies and guidance point up the importance accorded program management as uniquely practiced in the Air Force.

Unique features of Air Force program management

The unique features of program management in the Air Force are primarily disadvantages which compound the complexities already inherent in a program manager's job. The following unique features were identified by the Logistics Management Institute (LMI) and are important to keep in mind when evaluating qualifications of a program manager (14:49):

1. Program managers are rotated and/or promoted to other assignments with little regard to program life cycle. Tenure does not parallel system life cycle.

2. In general, there are too many layers of authority between program managers and their service secretaries. Figure 2 illustrates the typical layers of authority.

3. The program manager's grade significantly enhances his stature with his superiors and his ability to obtain responsive support from functional organizations.

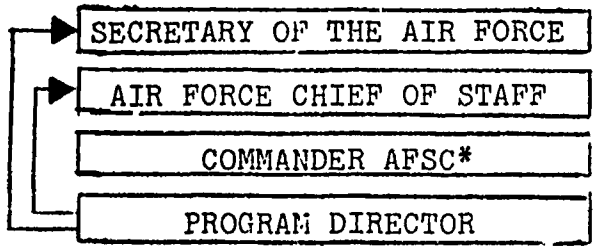

Figure 2. Layers of Authority Above Program Manager

*Advisory function only, not program direction (22:49).

4. There is no protection against the imposition by organizations below the level of the chartering authority of across-the-board personnel reductions-in-force, bumping chains, etc.

5. Program managers spend considerable time and effort preparing for and testifying at Congressional hearings in defense of their programs and vying for resource dollars.

6. Seldom is a program manager at an organizational level equal in rank to the functional elements upon which he relies for support.

7. The program manager does not have sufficient authority and/or capability to control funds, budgeting and scheduling for the program because of: (1) congressional control and influence, and (2) program, not line control over functional areas. Figure 3 shows a typical program office organization chart. Figure 4 shows program and functional authority relationship.

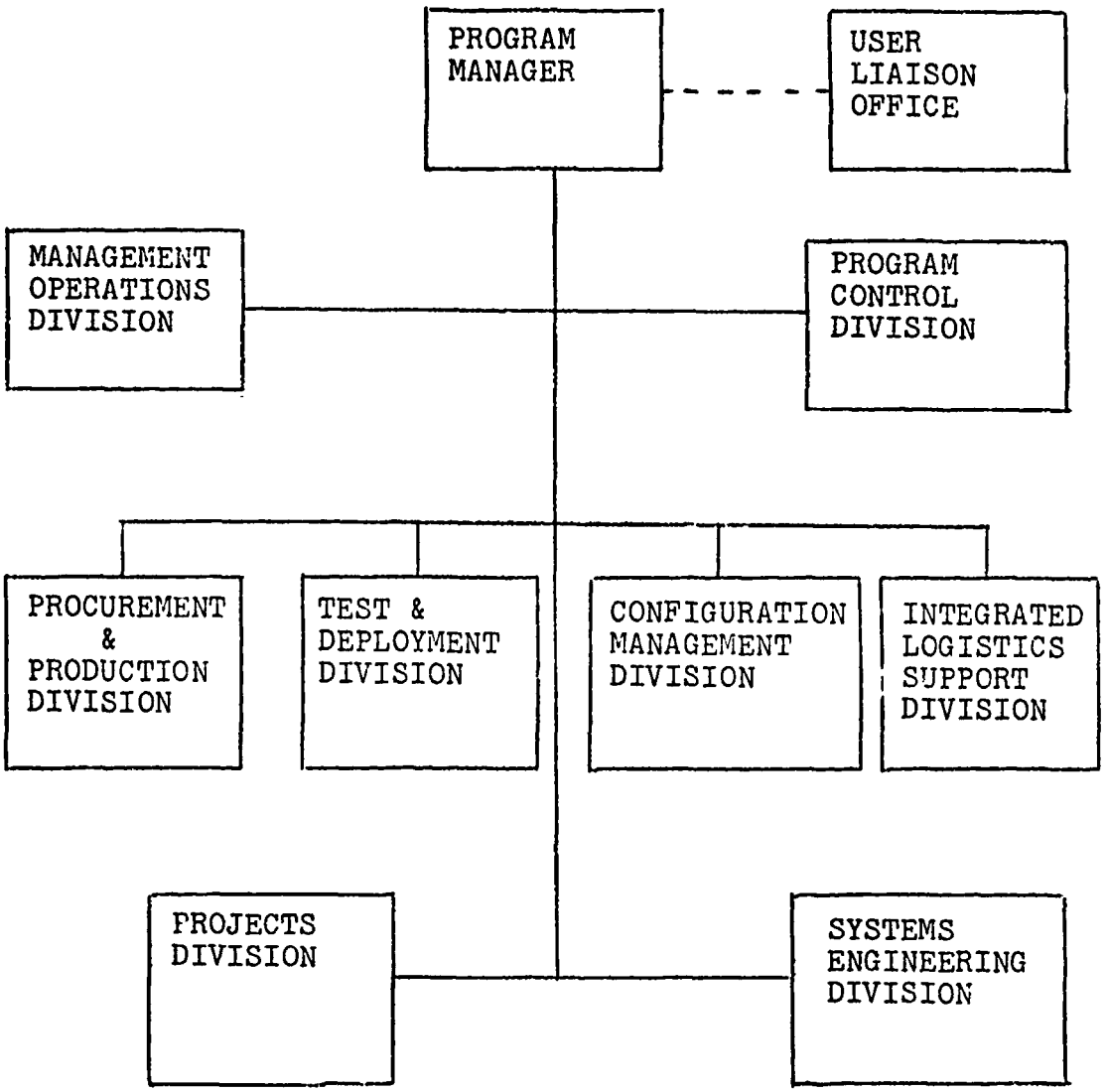

Figure 3. Typical Air Force Program Management Office Organization Chart

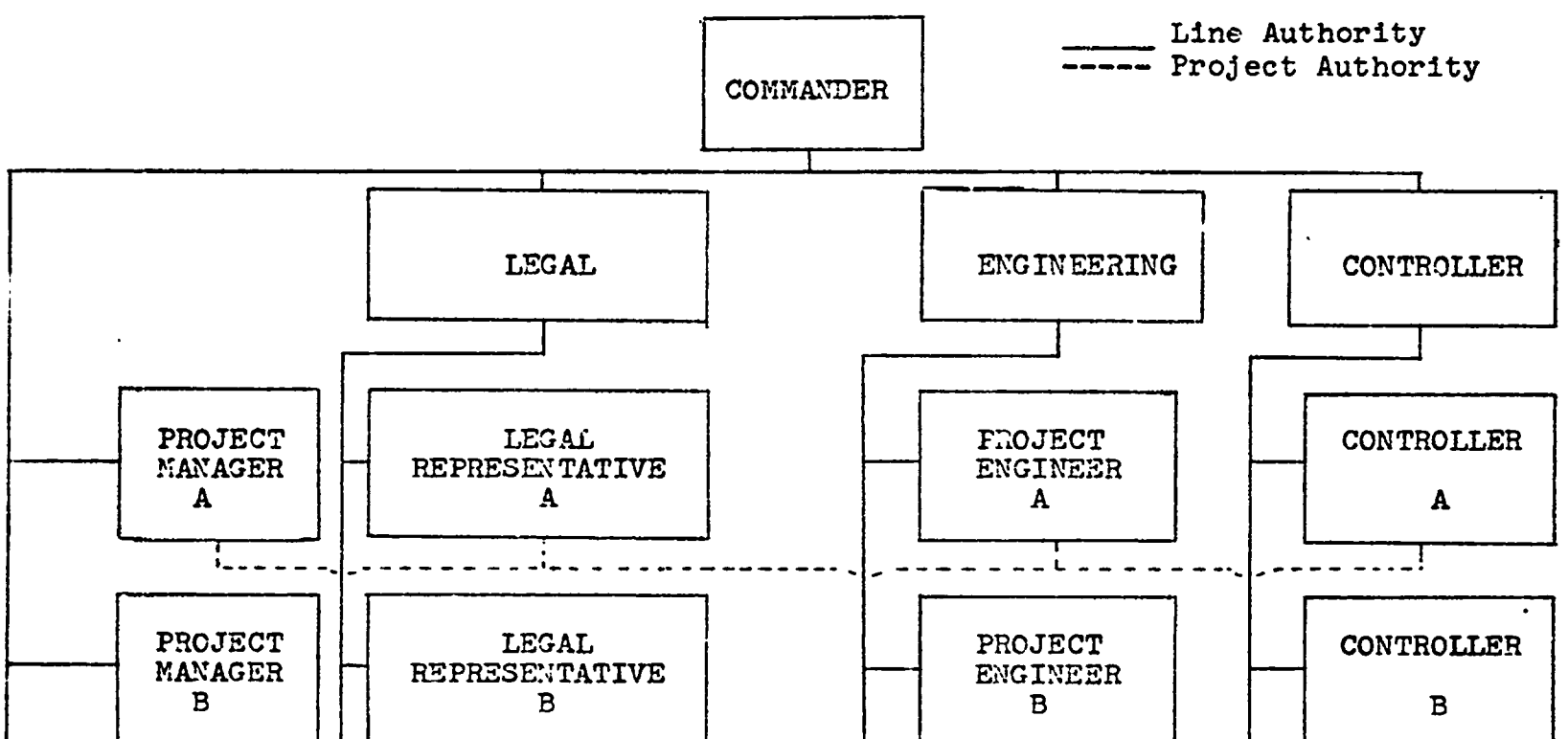

Figure 4. Program and Functional Authority Relationship

8. Risk assessment is usually the impetus to a program management organizational structure. Within the Air Force, risk assessment equates to national security.

Summary

This brief look into the evolution of program management, and more particularly into the role the program manager plays within the complexities of the program management structure and the prominence program management has assumed throughout top management should serve to highlight the need for identifying a minimum set of standards desired of a program manager. These standards are particularly necessary if there is a difference in qualifications desired during various stages of the program life cycle.

This section has served to provide background information on the nature of project management in the Department of the Air Force by tracing its evolution and looking at the Air Force's recognition of the need to improve the quality of its program managers. This review sets the stage for efforts to examine the program manager today, survey opinions of program managers, and identify desired program manager qualifications at different stages in the program life cycle.

Objectives

This research attempted to identify the major qualifications desired of a program manager during the different stages of the life cycle of a program. Information was collected and evaluated on present System Program Office (SPO) managers. The data was categorized with regard to the stage of the program under consideration so that differences, if any, could be compared and tested. It is expected that the resulting information may be used as a basis for programming educational, experience, and managerial trait requirements into the selection and training process of program managers. It is hoped that this research effort will provide the Air Force with a viable "yardstick" with which to meet the challenge of selecting the right program manager for the right job.

Research Hypotheses

The following hypotheses follow from the identified importance of the managerial qualifications of the program manager and the unique varying tasks associated with the different stages of the acquisition life cycle:

1. There is a difference in the educational qualifications desired of program managers between stages of the acquisition life cycle.

2. There is a difference in the experience qualifications desired of program managers between stages of the acquisition life cycle.

3. There is a difference in the managerial trait qualifications desired of program managers between stages of the acquisition life cycle.

CHAPTER II

RESEARCH METHODOLOGY

General Approach

This study assessed the differences in the major qualifications desired of a program manager over the program acquisition life cycle through an extensive literature search and by administering a structured interview to program managers of major Air Force Weapon System Programs. The interview responses were rank ordered, in order of their perceived importance to the interviewee, and statistical tests were made on the data for measures of association/agreement. The tests of association are:

1. Spearman's rank correlation coefficient (19:202) was used as a measure of association/agreement among interview rankings to determine if differences exist in the major qualifications desired of program managers in the young, mature, and old stages of the acquisition life cycle.

2. Spearman's rank correlation coefficient was used to determine the degree of association between the interview responses based on the product center assigned (i.e., ASD versus ESD, etc.) If agreement was found to exist, it was assumed there was no bias associated with location/type of program, and thus responses from all three product divisions could be combined.

Method of Information Collection

The two primary methods used in collecting information for this study were library research and personal interviews. Figure 5 provides a summary of the methodology used to answer the research hypotheses.

Library research. The authors completed a library search using the following topics: program manager, program management, systems management, matrix management, system program directors and Air Force managers. Research of the literature resulted in an ample amount of both military and civilian background information on the thesis topic.

Personal interview. The use of the personal interview imposes certain limitations in that it is costly in terms of time and human bias. The many advantages of an interview, however, outweigh these limitations. One of the advantages of an interview is that this technique enables a high percentage of returns and a better sample than might be collected through use of another data gathering procedure. Frequently, the information is more correct since supplementary information can be collected, and return visits can be accomplished, if necessary. Another advantage of the personal interview technique in this study was that data collected was classified as primary since it was collected by the researchers functioning in the capacity of interviewers.

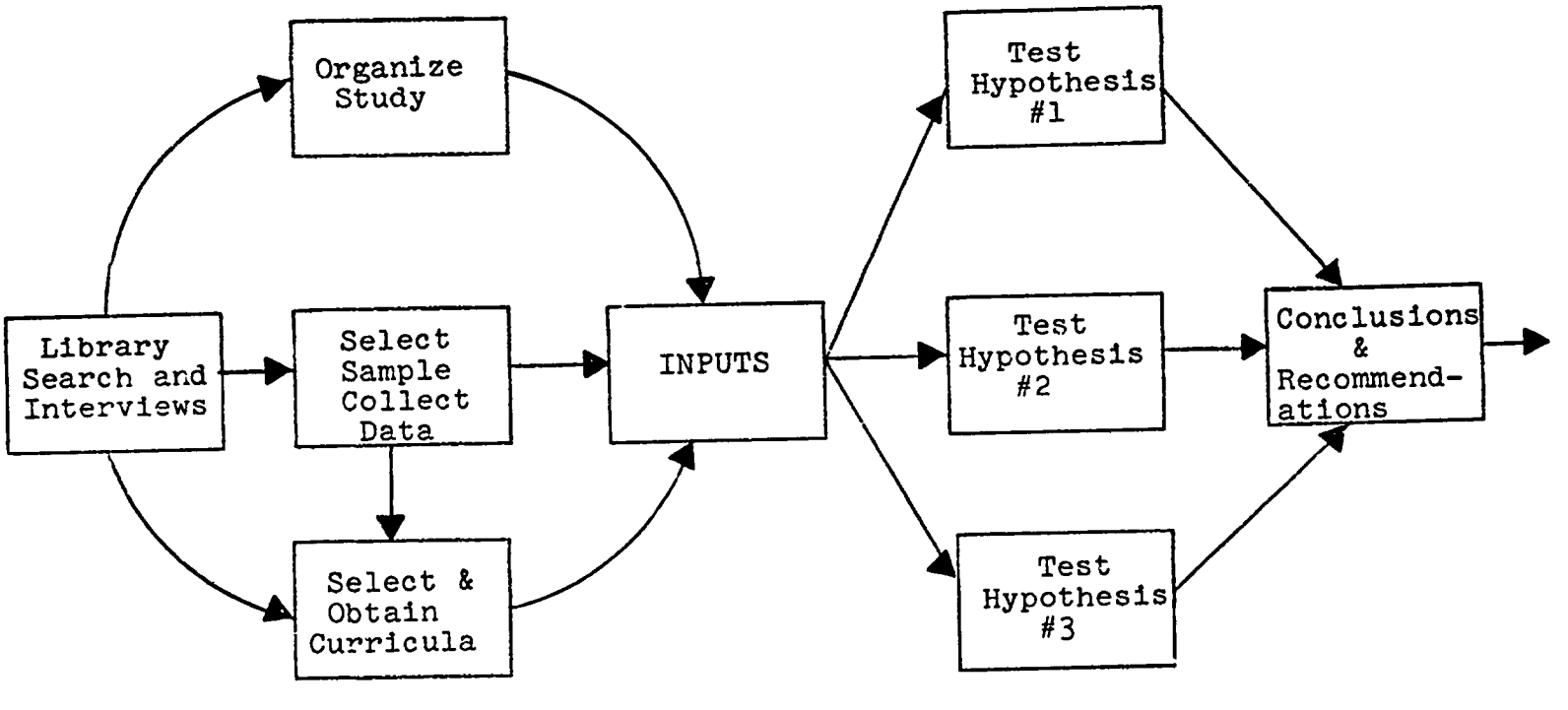

Figure 5. Flow Diagram of Thesis Methodology.

Of all the advantages, however, perhaps the most important is control. Marshall and Pratt, (15:19) in their thesis, An Analysis of Strategy and Tactics Employed in Contract Negotiations, viewed the interview as far more versatile and flexible than either observation or the use of documents. In the interview, the researcher can exert some control over the responses of the informant. In cases of ambiguity in the responses received, the interviewer can seek on-the-spot clarification and not be dependent upon his recall of what transpired during data collection. Where responses are inadequate, the interviewer can seek amplification. Because of these many advantages, the interview was selected as the most appropriate technique for the collection of valid data to test the research hypotheses.

Information Requirements

The following null hypotheses were tested:

1. There is no difference in the educational qualifications desired of program managers between stages of the acquisition life cycle.

2. There is no difference in the experience qualifications desired of program managers between stages of the acquisition life cycle.

3. There is no difference in the managerial trait qualifications desired of program managers between stages of the acquisition life cycle.

To evaluate these hypotheses, a measure of association was made of the major qualifications; education, experience, and managerial traits desired by major program managers. The qualifications identified were correlated with the stages of the acquisition life cycle. For the purposes of this study the stages of the acquisition life cycle were defined to be:

1. Young. Includes the conceptual and validation phases.

2. Mature. Represents the Full-Scale Development Phase.

3. Old. Includes the production and deployment phases.

The realigning of the stages of the acquisition life cycle was done for two reasons; (1) for the ease of data collection and comparison, and (2) redefinition of the phases into the young, mature and old stages represent the major program threshold decision points (24:2). In this context a decision point is the point in time that a "go" or "no-go" decision is made to proceed to the next phase of the program (24:2).

Normally the acquisition life cycle consists of all five steps (conceptual, validation, full-scale development, production, and deployment), but not all programs follow a prescribed path. A program may skip a phase, have program elements in any or all other phases, or have multiple decision points per phase (24:2).

It was felt that the program decision points were the critical milestones of each program and provided a more distinct reference point from which to compare the data base. The information obtained identified the characteristics desired in each of the major qualification areas and was classified into one of the life cycle stages for comparison and testing of the hypotheses.

Population Under Study

General. The population of the study under consideration included all major Air Force defense programs so designated by the Secretary of Defense/Deputy Secretary of Defense and identified by definition in Department of Defense (DoD) Directive 5000.1 to be (21:1):

1. Dollar value (programs which have an estimated RDT&E cost in excess of 50 million dollars, or an estimated production cost in excess of 200 million dollars.

2. National urgency.

3. Recommendations by DoD Component Heads or Office of Secretary of Defense (OSD) officials.

Program managers studied. The data-producing sample consisted of Air Force System Program Managers whose programs met the above criteria. This sample consisted of the entire population under study and hence was representative of that population.

System program managers interviewed included the System Program Directors (SPDs) of major programs at Air Force System Command's (AFSC) three major product divisions: (1) Electronic Systems Division (ESD), Hanscom Field, Massachusetts; (2) Aeronautical Systems Division (ASD), Wright-Patterson AFB, Ohio; and (3) Space and Missile Systems Organization (SAMSO) Los Angeles Air Force Station, California. Figure 6 illustrates the position of the three product centers within the Air Force organizational structure. Figures 7, 8, and 9 show the organizational positions interviewed by product division, ASD, ESD, and SAMSO, respectively.

Data Base and Data Validity

The data was obtained from personal interviews with each of the directors of major weapon system programs indicated previously.

The rank and position of program managers was assumed to be adequate to validate data gathered via the prime source. More specifically, the rank and position held by members of the population was assumed to qualify them to identify those characteristics most helpful in the performance of their duties.

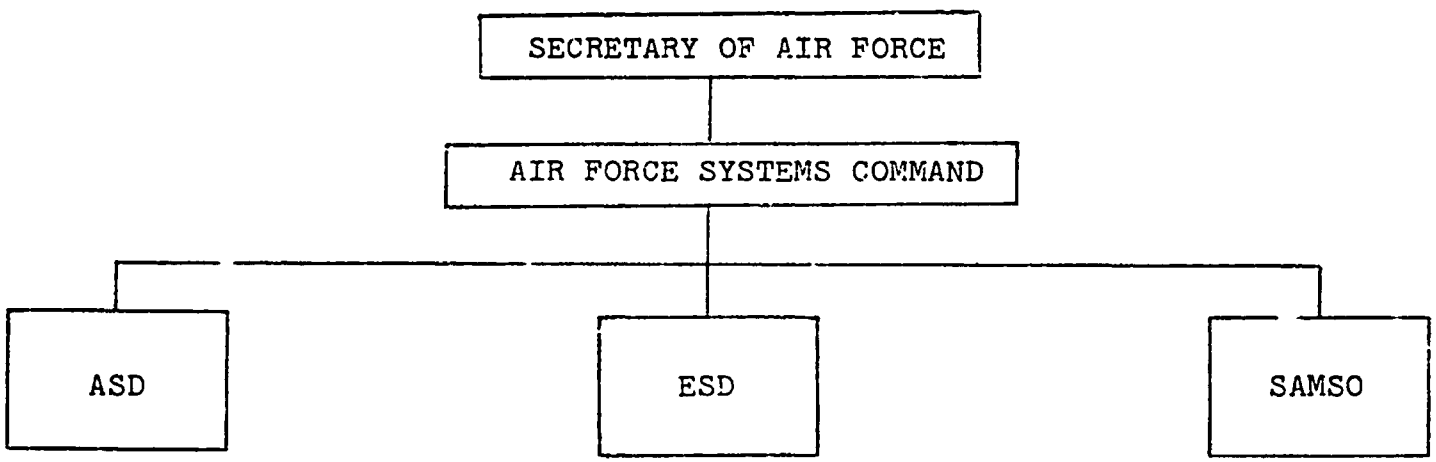

Figure 6. Product Centers Positioned Within the Air Force Organizational Structure.

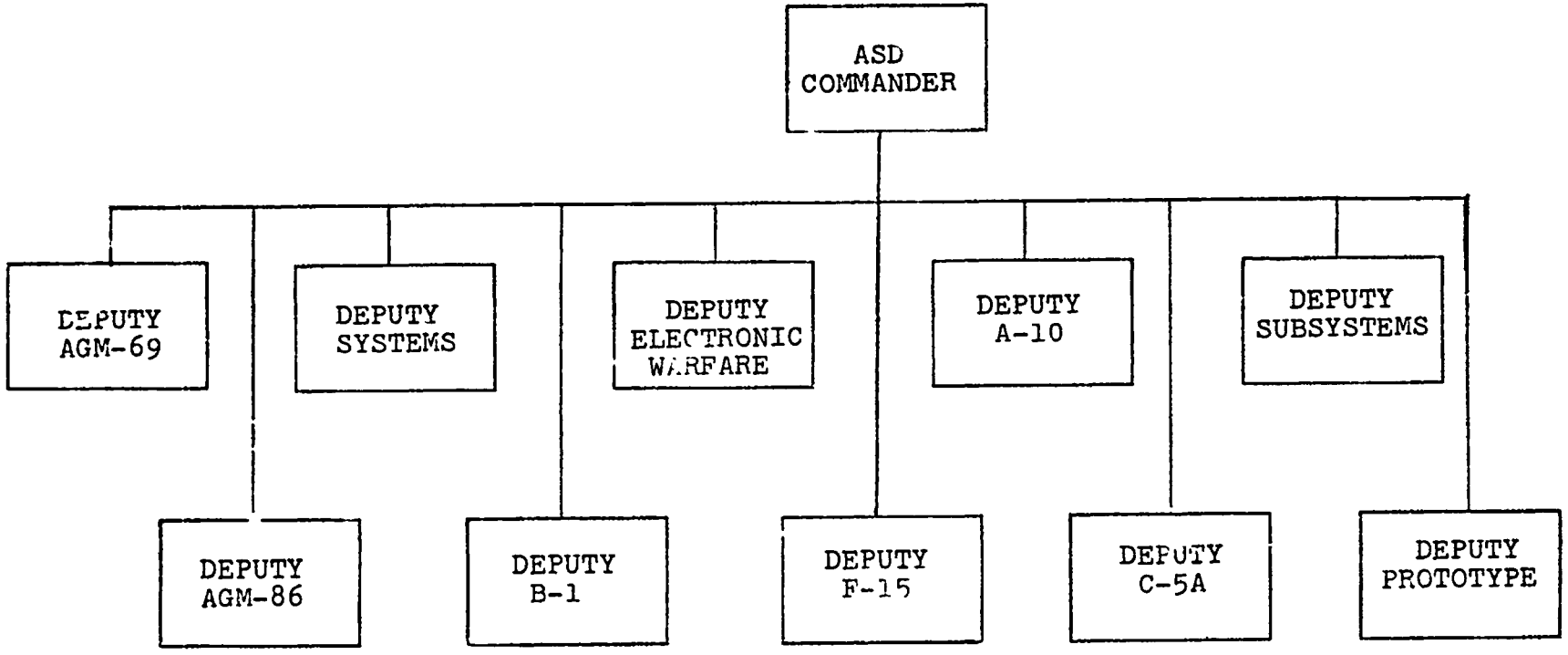

Figure 7. Aeronautical Systems Division Organizational Positions Interviewed.

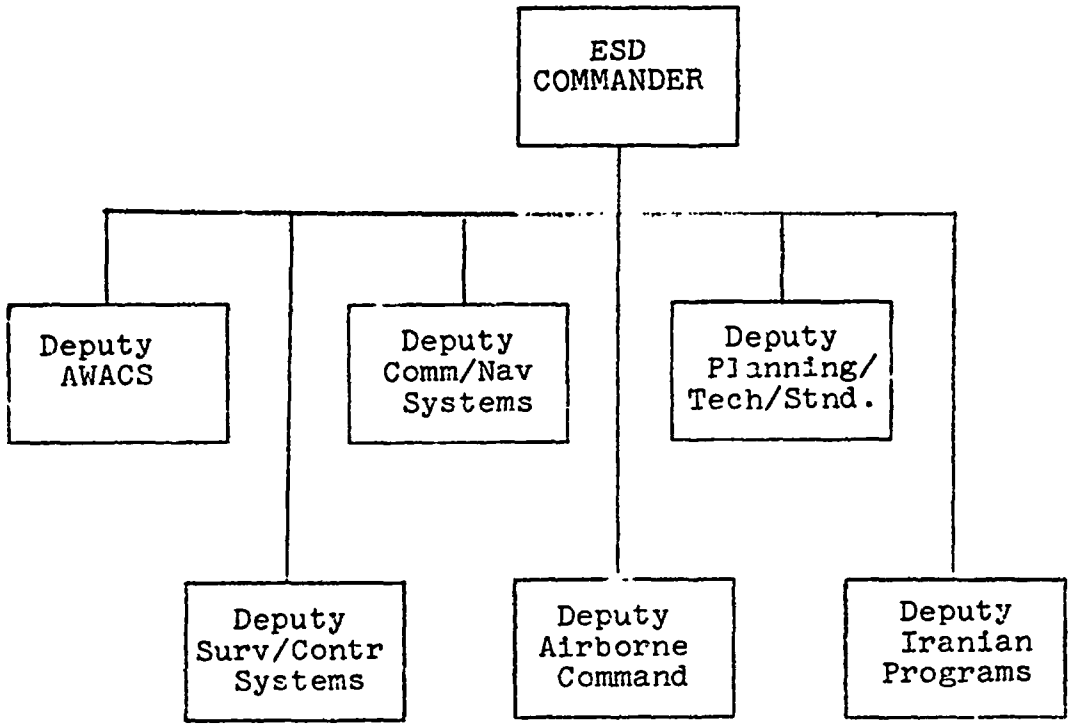

Figure 8. Electronic Systems Division Organizational Positions Interviewed.

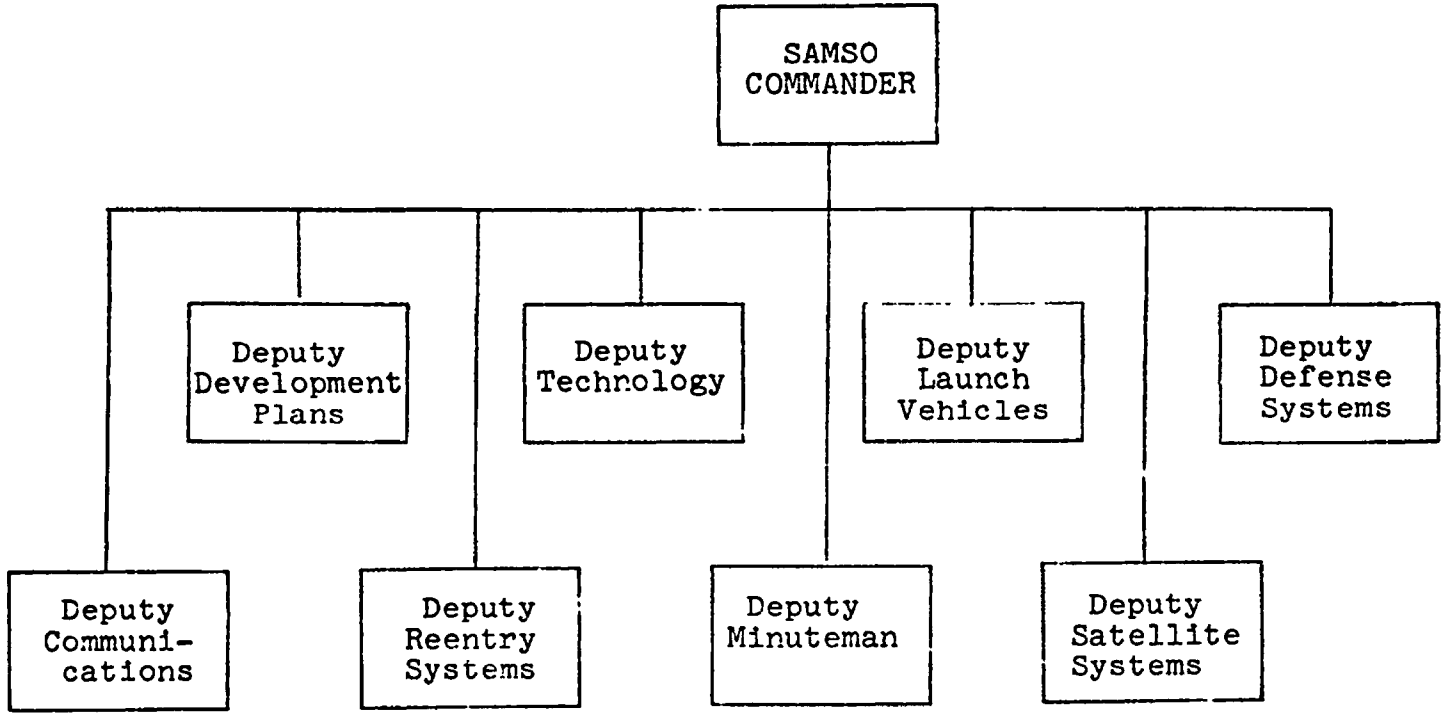

Figure 9. Space and Missile Systems Organizational Positions Interviewed.

Variables Under Consideration

The variables studied were experience, education, managerial traits and stage of acquisition life cycle. The first three are dependent variables and are categories of characteristics selected because of their encompassing nature and critical impact as discussed below. Each dependent variable was categorized into a discrete limited number of characteristics for purposes of measurement. The individual characteristics are nominal in nature, but when rank ordered, the resulting data is on an ordinal scale. The fourth variable, stage of acquisition life cycle, is the independent variable, nominal data, representing three separate stages over which the dependent variables were evaluated. Figure 10 shows the relationship between the dependent and independent variables. Specific rationale for selection of each of the variables measured include:

Education. Education was selected as a dependent variable because of the many diversified functional disciplines both under the program manager's purview, and those outside of his line of authority for which he requires support (24:54). For example, the program manager must be cognizant of the financial requirements and controls, must be aware of personnel manning and managing, be able to critically review engineering design and evaluation, and be a systems integrator. The degree and

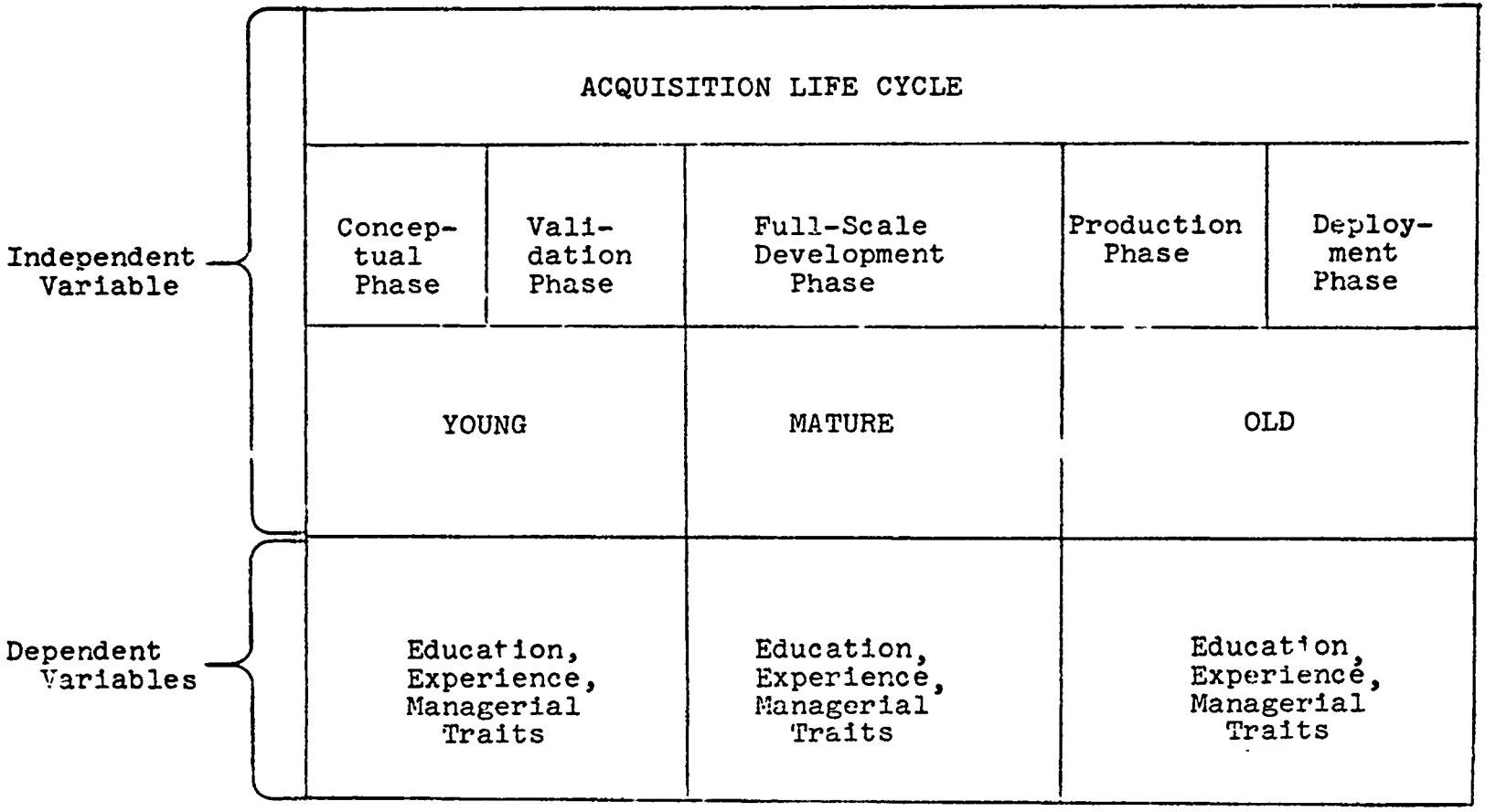

Figure 10. Independent and Dependent Variable Relationships.

academic area desired was focused on the graduate level. The basis for this choice was the preponderance of data from library research which indicated the necessity of a graduate degree for a project manager (20:29; 7:48; 3:19). Information pertaining to desirable education for managers, both military and industrial, point out the need for both technical and business administration/management training and expertise. A basic assumption was made that prospective SPDs would possess a technical background, via a scientific, mathematical, or engineering bachelor's degree. This assumption is backed up by previous studies in the same area which have indicated that over 99% of SPDs have a formal technical baccalaureate degree (3:19). For this reason the undergraduate degree was not considered as a variable for purposes of questioning. The interviewees were advised of this assumption in each case. Specific selection of responses available were derived from other surveys, questionnaires, and interviews relating to similar topics of investigation (12:41; 7:62; 3:74). Specifically, to evaluate educational qualifications desired of a program manager, interviewees were asked to rank order (priority 1 through 5) such graduate degree programs as: Business Management, Personnel Management, Financial Management, Operations Research and Engineering.

Experience. This variable was selected for study and comparison because of the complex nature of the program manager's job. For example, the program manager functions as a central activity dealing with many echelons above his program up to, and including, the Secretary of the Air Force as well as the functional agencies and user commands (12:42). The interviewee was asked to rank order (priority 1 through 4) the following characteristics:
(1) Headquarters, Air Staff, Numbered Air Force experience; (2) Command or operational experience; (3) Engineering/ Laboratory experience; or (4) System program management experience. The characteristics used were selected from similar studies (3:19; 1 ·41).

Managerial traits (personality). Managerial traits was the most difficult of the three variables to evaluate. The search for characteristics that spell success in men in leadership or executive roles is not a recent phenomenon. Socrates advanced temperance, courage, justice and wisdom as the virtues that make men good (20:23). Homer's writings reflected justice, judgement, wisdom, craft, and valor as the qualities of leadership. Extensive library research of works by Likert, Sayles, and others produced approximately 60 desirable managerial traits. Many were similar or nearly identical in meaning. The authors narrowed this list down to a total of seven. The traits selected were felt to be sufficiently representative

of those researched as to encompass a wide range of characteristics desired. In three of the seven traits similar meanings were combined so as to convey a more accurate description of the desired managerial traits. As a result, it was assumed a more meaningful delineation of traits was achieved. Specifically for this thesis, to evaluate the quality characteristics desired of a program manager, interviewees were asked to rank order (priority 1 through 5) such qualities as: communicative skill, decision making ability (decisiveness), imagination, motivation (himself and others) and self confidence.

Stage of acquisition life cycle. Detailed definitions and explanations of the various stages of the life cycle, (young, mature, old) were provided in detail in the Information Requirements section of this thesis. Suffice it to say that desired qualifications of program managers may change as stage of program life cycle and predominant managerial tasks change.

Research Instrument

As previously mentioned, a structured interview was used to gather the data required for testing the hypotheses. (See Appendix A.) The interview instrument consisted of two parts; (1) a basic general background section on the interviewee, and (2) the major qualification section, with experience, education, and managerial trait questions.

The interviewees were asked to rank order the major qualifications in the order of importance toward meeting the objectives of the program management stage of the life cycle under observation. The rank ordered data obtained from the interview is ordinal in nature thereby suitable for measure of association (agreement) testing described in detail in the Testing the Hypotheses chapter of this thesis.

Pilot Study of the Structured Interview

The authors conducted a pilot study of the research instrument on Wright-Patterson AFB, Ohio. Several interviewees were selected from the program managers of the smaller program offices and directorate level chiefs of the major programs under study. Many constructive comments were made which led to the reorganizing of questions on the interview. Expert guidance was received from these individuals pertaining to questioning techniques which they felt would be most effective. Reliance on their experience and judgement led to a deletion of ambiguous, confusing, or irrelevant questions on the test instrument.

Interview Methodology

The interviewee was initially advised of the purpose of the interview, then was handed a sheet of paper with a list of responses to the various questions. He was assured

that his responses would be grouped with those of other interviewees, and was guaranteed total anonymity so as to minimize biases and/or prejudices which could result from the subject feeling that he was being compared to other program managers. If this were the case he might respond to the interview questions as he would perceive other program managers would, and not necessarily express his own real feelings. Each interviewee was asked to respond for the stage in the life cycle in which he felt that he was particularly knowledgeable or experienced in. Each interviewee could thus answer for 1, 2, or 3 stages of the life cycle.

The interviewee was also advised that concurrency was acknowledged across the spectrum of the life cycle, but that for purposes of demarcation of major go-no-go decision points, the cycle was partitioned into three stages instead of the traditional five; (1) conceptual and validation (young), (2) full-scale development (mature), and (3) production and deployment (old). He could then presumably formulate his answers with the three stages in mind.

Assumptions

1. The sample was confined to major program offices on the assumption that results gained from the analysis would not be inapplicable for smaller program offices. This assumption is based on the premise that if a program manager can manage a large complex program he can also manage a smaller, simpler program, and in fact, probably has.

2. Education, experience and managerial trait factors are the inclusive major qualifications required of a program manager.

3. The data collected for this study is valid. This assumption is based on an examination of the process by which the data is generated, collected and accumulated as described in the section of this thesis in the Population Under Study section. The time limits on this study did not allow a rigorous validation of the generated data.

4. The management concept based on type of program, aircraft versus missile, etc., is not significantly different with respect to its influence on data collection.

5. The program manager in the population observed was qualified in his present position, and therefore was qualified to identify the major qualifications needed to accomplish his job.

Limitations

The study was limited to the top program management offices in the Air Force, which provided a manageable basis from which to evaluate, analyze, and predict those characteristics required of a program manager. As a consequence, the results of the study can be considered to be directly applicable to Air Force program management only. Inference to other services will be a matter of judgement on the part of the reader.

CHAPTER III

TESTING THE HYPOTHESES

Introduction to Data Analysis

As previously mentioned in this thesis, data was collected in the form of rank ordered interview responses from major program managers. Each interviewee rank ordered his preferences in each of three different categories, i.e., education, experience, and managerial traits, for each stage in the acquisition life cycle for which he felt he was qualified to comment on. The authors determined that if a program manager provided responses for a particular stage of the life cycle, and had less than one year of experience in that stage, his response was purged from the data base. The one year minimum experience criteria in each stage was verified by interview questions and complimentary research of biographical information. Upon completion of the data purging, the data base consisted of interviews with twenty-four System Program Directors. (See Appendix B.)

Compilation of Data

Interviewees were asked to respond with their selections in order of preference, 1 through 4, of the four available choices in the Experience category. They were

also asked to rank order 1 through 5 of those available choices in both the Education and Managerial traits categories. Although there were 11 and 7 available choices, respectively, in the Education and Managerial Trait categories, it was felt that validity of selection would be considerably lessened after the first five selections. In other words, each succeeding selection would become less relevant to the interviewee in terms of discrimination between available choices.

Concern over possible variation due to differences between product centers because of geographical location and/or program differences led the authors to test for agreement between centers. A comparison of data between product centers was accomplished using the Spearman rank correlation coefficient. It was concluded that no damaging bias was present, and that the data could be combined for testing. (See Appendix C.)

Rank Ordering Procedure

Rank orderings for all categories were then inverted, thus making the first choice the highest number, and the last choice, number one. This inversion was necessary to minimize the bias that might occur when an alternative was not chosen, or chosen only a few times The values of characteristics in each category were totalled to give composite values. These composite values

were then rank ordered with the highest value considered to be the highest rank. The composite values were functions of both frequency of selection of characteristics and the relative preference accorded by each interviewee. The rank orderings were used as the measures of comparison between the stages of the life cycle. Rank orderings were obtained for each of the three categories, i.e., education, experience, and managerial traits in each of the three stages (young, mature, and old) of the acquisition life cycle. This classification of rank orderings thereby allows each dependent variable to be subdivided into three subsets, one for each category of the independent variable. Thus, the education variable could be considered to be composed of the three subsets: desired educational qualifications in the young stage, educational qualifications in the mature stage, and educational qualifications in the old stage. The experience variable and the managerial traits variable were similarly treated. This classification of rank orderings thereby provided nine distinct variables (Figure 11) which were then used to test the three hypotheses identified in Chapter I.

Rationale for Use of Spearman Rank Correlation Coefficient

In parametric statistics, the usual measure of correlation is the Pearson product-moment correlation coefficient (r). This statistic requires scores or values

	Stages of Life Cycle		
Qualifications	Young	Mature	Old
Education	Education/ Young	Education/ Mature	Education/ Old
Experience	Experience/ Young	Experience/ Mature	Experience/ Old
Managerial Traits	Managerial Traits/ Young	Managerial Traits/ Mature	Managerial Traits/ Old

Figure 11. Variables Under Measurement

which represent measurement in at least an interval scale (19:195). Since interval scales of measurement were not met in the data, the use of a nonparametric correlation coefficient was necessary. Several nonparametric measures are potentially applicable when nominal or ordinal data is available (19:30). The Spearman rank correlation coefficient is a frequently used nonparametric test that is applicable when two rank ordered individuals or objects are compared to each other for a measure of association or agreement (19:202). Specific reasons for the use of the Spearman rank correlation coefficient in this research are:

1. It requires no assumptions concerning the shape of the population from which the set of values is taken (19:31).

2. It requires only measurement of values on an ordinal scale (10:839). Ordinal measurement means that the numerical values obtained give information only about relative magnitudes of the underlying variable, and arithmetic differences between values have no particular significance (10:814).

3. The computations required to determine the coefficient are neither complicated nor extensive (19:33). This was a decided advantage considering the number of tests performed.

The coefficient, sometimes called rho, is represented here as r_s, and can vary from -1.0, perfect negative correlation, i.e., perfect disagreement, to + 1.0, perfect positive correlation or agreement.

The Spearman Test

The basic methodology employed in using the test is to rank order two variables in order of preference by N choices as in X_1, X_2, X_3,... X_N, and Y_1, Y_2, Y_3....Y_N. Then a measure of correlation is used to determine the relation between the X's and Y's. An indication of disparity in the rankings is observed by: $D_i = X_i - Y_i$. If the relation between the two rankings were perfect, each D would be zero. The larger the D_i's, the less perfect is the relationship between the two variables. In computing a correlation coefficient, it is more convenient to use

D_i^2 instead of D_i in order to eliminate the cancellation effects of positive and negative D_i's (19:202).

The formula selected to compute the Spearman r_s is:

$$r_s = 1 - \left[\frac{6 \sum_{i=1}^{N} D_i^2}{N^3 - N} \right]$$

(19:204)

Setting of Acceptance Level

The level of agreement between two variables will vary from -1.0 to +1.0. Inferences may be drawn based upon the value plus the sign of the computed r_s. For example, if the computed value was -.75, one could infer disagreement in the rankings of the N factors by the two groups, as did Marshall and Pratt (15:29-30), thus implying a lack of consistency in rankings. However, if the computed value of r_s was +.75, one could logically infer that there was a strong agreement between the ranking of the N factors by the two groups, and thus, the ranking by one group was consistent with that of the other group. An r_s of 0.0 indicates an intermediate condition of no agreement in either direction. The authors selected an r_s of .75, which was considered to be sufficiently large to indicate substantial agreement of the rankings compared.

Hypothesis Test Format

If the Spearman rank correlation coefficient (r_s) were found to be equal to or greater than .75, there would be no reason to reject the null hypothesis. If the r_s value were found to be less than .75, the null hypothesis would be rejected and the research hypothesis would be supported.

The following format is used to present the Test of Research Hypothesis Sections: (1) restatement of the research hypothesis; (2) restatement of the null hypothesis; (3) presentation of data; and (4) interpretation of findings.

Test of Research Hypothesis No. 1

Restatement of the research hypothesis. The research hypothesis tested was:

H1: There is a difference in the educational qualifications desired of program managers between stages of the acquisition life cycle.

Restatement of the null hypothesis. The research hypothesis tested in its null form is:

H0: There is no difference in the educational qualifications desired of program managers between stages of the acquisition life cycle.

Presentation of data. The values of the Spearman rank correlation coefficient (r_s) for comparison of rank

orderings of educational qualifications between stages of the acquisition life cycle are presented below:

stage versus stage	value of r_s
young versus mature	.16
young versus old	-.02
mature versus old	.95

Interpretation of findings. As presented above, the r_s values for the young versus mature, and young versus old stages are both less than .75. Therefore, in accordance with the decision rule, it was concluded that there is a difference in the educational qualifications desired of program managers between the young and mature stages, and between the young and old stages of the acquisition life cycle. The computed r_s value for the mature versus old stage is greater than .75. Therefore, in accordance with the decision rule, there is no difference in the educational qualifications desired of program managers between the mature and old stages of the acquisition life cycle. Thus, the research hypothesis was supported for the young versus mature, and young versus old, but not supported for the mature versus old stages of the acquisition life cycle.

Test of Research Hypothesis No. 2

Restatement of the research hypothesis. The research hypothesis tested was:

H1: There is a difference in the experience

qualifications desired of program managers between stages of the acquisition life cycle.

Restatement of the null hypothesis. The research hypothesis tested in its null form is:

HO: There is no difference in the experience qualifications desired of program managers between stages of the acquisition life cycle.

Presentation of data. The values of the Spearman rank correlation coefficient (r_s) for comparison of rank orderings of experience qualifications between stages of the acquisition life cycle are presented below:

stage versus stage	value of r_s
young versus mature	-.2
young versus old	-.2
mature versus old	1.0

Interpretation of findings. As presented above, the r_s values for the young versus mature and young versus old stages are both less than .75 Therefore, in accordance with the decision rule, it was concluded that there is a difference in the experience qualifications desired of program managers between the young and mature stages, and between the young and old stages of the acquisition life cycle. The computed r_s value for the mature versus old stage is greater than .75. Therefore, in accordance with the decision rule, there is no difference in the experience

qualifications desired of program managers between the mature and old stages of the acquisition life cycle. Thus, the research hypothesis was supported for the young versus mature, and young versus old, but not supported for the mature versus old stages of the acquisition life cycle.

Test of Research Hypothesis No. 3

Restatement of the research hypothesis. The research hypothesis tested was:

H1: There is a difference in the managerial traits qualifications desired of program managers between stages of the acquisition life cycle.

Restatement of the null hypothesis. The research hypothesis tested in its null form is:

HO: There is no difference in the managerial traits qualifications desired of program managers between stages of the acquisition life cycle.

Presentation of data. The values of the Spearman rank correlation coefficient (r_s) for comparison of rank orderings of managerial traits qualifications between stages of the acquisition life cycle are presented below:

stage versus stage	value of r_s
young versus mature	.86
young versus old	.78
mature versus old	.99

Interpretation of findings. As presented above,

r_s values for all comparisons are greater than .75. Therefore, in accordance with the decision rule, there is no difference in the managerial trait qualifications desired of program managers at different stages of the acquisition life cycle. Thus, there was no reason to reject the null hypothesis.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE STUDY

Introduction

This chapter presents the conclusions related to research hypotheses No. 1, 2, and 3. Included also are recommendations for further research.

Research Hypothesis No. 1 Findings

Table 1 summarizes the findings cited in Chapter III relative to desired educational qualifications of program managers (Research Hypothesis No. 1).

TABLE 1

Research Hypothesis No. 1 Findings

Test	Test Results		
Comparison of Stages	Computed r_s	Decision Rule	Interpretation
Young versus Mature	.16	less than .75	Supported
Young versus Old	-.02	less than .75	Supported
Mature versus Old	.95	less than .75	Not Supported

Research Hypothesis No. 1 Conclusions

As shown in table 1, there is a difference in the educational qualifications desired of program managers between the young and mature, and the young and old stages of the acquisition life cycle, but not between the mature and old stages. A practical interpretation of this difference is found by looking at the raw data responses, which indicated an overwhelming emphasis on engineering disciplines in the young stage of the life cycle; whereas primary emphasis was placed on the management disciplines in the mature and old stages.

Research Hypothesis No. 2 Findings

Table 2 summarizes the findings cited in Chapter III relative to desired experience qualifications of program managers (Research Hypothesis No. 2).

TABLE 2

Research Hypothesis No. 2 Findings

Test	Test Results		
Comparison of Stages	Computed r_s	Decision Rule	Interpretation
Young versus Mature	-.20	less than .75	Supported
Young versus Old	-.20	less than .75	Supported
Mature versus Old	1.00	less than .75	Not Supported

Research Hypothesis No. 2 Conclusions

As shown in table 2, there is a difference in the experience qualifications desired of program managers between the young and mature, the young and old stages of the acquisition life cycle, but not between the mature and old stages. A practical interpretation is easily discernible as was the difference in the educational qualifications desired.

The composite rank ordering of desired experience characteristics selected by program managers in the young stage by priority was; (1) Engineering/Laboratory experience, (2) System Program Management experience, (3) Headquarters/Air Staff experience, and (4) Command/Operational experience.

In the mature and old stages, which had a direct one-to-one agreement (perfect association), the rank ordering by priority was; (1) System Program Management experience, (2) Headquarters/Air Staff experience, (3) Command/Operational experience, and (4) Engineering/Laboratory experience.

As can be seen from the rank orderings, the significant difference lies in the fact that Engineering/Laboratory experience was the first choice in the young stage, but ranked last in the mature and old stages. With this one exception, the remaining experience characteristics were in the same relative order of importance.

Stated in general terms, program managers preferred

Engineering/Laboratory experience in the young stage, but placed it as least preferred in the mature and old stages. This change of preference placed System Program Management experience as the most desired in the mature and old stages.

Research Hypothesis No. 3 Findings

Table 3 summarizes the findings cited in Chapter III relative to managerial trait qualifications of program managers (Research Hypothesis No. 3).

TABLE 3

Research Hypothesis No. 3 Findings

Test	Test Results		
Comparison of Stages	Computed r_s	Decision Rule	Interpretation
Young versus Mature	.86	less than .75	Not Supported
Young versus Old	.78	less than .75	Not Supported
Mature versus Old	.99	less than .75	Not Supported

Research Hypothesis No. 3 Conclusions

As shown in table 3, there is no significant difference in the managerial traits desired of program managers between any of the stages of the acquisition life cycle. In fact, there is a very high agreement (association) from

one tage to another of the managerial traits desired of a program manager.

Overall Findings

Table 4 summarizes the findings cited in Chapters III and IV, relative to educational, experience, and managerial traits desired for program managers.

TABLE 4

Overall Research Hypotheses Findings

Qualifications	r_s Comparison by Stages		
	Young versus Mature	Young versus Old	Mature versus Old
Education	.16[a]	-.02[a]	.95
Experience	-.20[a]	-.20[a]	[illegible]
Managerial Traits	.86	.78	.99

[a]Research Hypothesis Supported $r_s < .75$

Note: Entries not supporting the research hypothesis are enclosed in double lines for ease of analysis/comparison.

Overall Conclusions

It is not feasible to have three program managers; one with the desired education qualifications, one with the desired experience qualifications and one with the desired managerial trait qualifications for each stage of the life cycle. This research has not tried nor does it show any such conclusion. This study does conclude however, that there is a definable point in the acquisition life cycle that it is logical and perhaps necessary (because of the relative magnitude of disagreement) to change the SPO manager based upon his particular background. This definable point is found between the young and mature stages.

Even though the research centered around comparing the categories of qualifications between three stages, table 4 shows little or no difference in the second and third stages; mature and old, respectively. This allows conclusions to be made treating the mature and old stages as one.

Table 4 shows there is not only a difference but a substantial difference in the education and experience qualifications desired of a program manager in the young stage (conceptual and validation phases) versus the education and experience qualifications desired of a program manager in the mature/old stages (full-scale development, production and deployment phases). The table shows little or no differences in managerial traits desired between stages.

To illustrate the differences mentioned it may be beneficial to contrast the desired image of a program manager in each stage.

Desired qualifications of a program manager during the young (conceptual and validation) stage. It was concluded that a program manager should have a strong engineering background during the conceptual and validation stage both from the educational as well as experience standpoint. This emphasis seems logical in view of the heavy engineering concentration carried on during the early development of a weapon system program.

Desired qualifications of a program manager during the mature (full-scale development) and old (production deployment) stage. This study concluded that once the program decision point is reached (between validation and full-scale development phase) and go-ahead is given, there is an overwhelming shift from engineering emphasis in the desired education and experience qualifications to that of managerial emphasis, particularly in the financial and personnel management areas.

Recommendations for Future Research

It is recommended that additional exploratory research be conducted, employing the methodology and conclusions found in this study along with the objective evaluation of each SPDs actual performance for possible correlation. For example, do Generals with prior unit

commander experience but no Hq Staff experience perform better than officers with Hq Staff experience and no command experience?

APPENDICES

APPENDIX A

STRUCTURED INTERVIEW

APPENDIX A

QUALIFICATIONS DESIRED OF AN AIR FORCE PROGRAM MANAGER DURING PHASES OF THE LIFE CYCLE

MASTER THESIS STRUCTURED INTERVIEW

OBJECTIVE

The objective of this interview is to obtain responses to questions relating to characteristics of education, experience, and managerial traits desired of program managers during stages of the acquisition life cycle. The responses will be rank ordered as to preference of the interviewee and grouped with responses from other program directors for measures of association between acquisition life cycle stages.

STRUCTURED INTERVIEW

Name
Interviewee _____ Date _____

Position _____ Grade _____

1. What stage of the acquisition life cycle is your program.

   a. Young (Conceptual and validated) _____

   b. Mature (Full-scale development) _____

   c. Old (Production and deployment) _____

2. How long have you been in your present assignment?

   a. Less than 6 months _____

   b. 6 months to one year _____

   c. Over one year to two years _____

   d. Over two years to three years _____

   e. Over three years _____

3. Based on your experience which five of the following graduate level majors (priority 1 through 5) do you feel best prepare a project manager for the young/mature/old stage of acquisition?

   a. Business Administration _____

   b. Financial Management _____

   c. Industrial Management _____

   d. Personnel Management _____

   e. Systems Management _____

   f. Electrical Engineering _____

   g. Mechanical Engineering _____

   h. Operations Research _____

   i. Mathematics _____

j. Science (specific field_____) _____

k. Engineering (specific field_____) _____

l. Other (specific field_____) _____

4. Based on your experience, rank in order of importance (1 through 4) the experience levels desired of the program manager in the young/mature/old stage of acquisition.

a. Command/operational experience _____

b. Headquarters, Air Staff, Numbered Air Force _____

c. Engineering/laboratory experience _____

d. System program management experience _____

e. Other (specify)_____) _____

5. Based on your experience, rank order (1 through 5) the managerial traits you feel are most desired of the program manager in the young/mature/old stage of acquisition.

a. Communicative skill _____

b. Decision making ability (decisiveness) _____

c. Imagination, creativity _____

d. Motivation, aggressivness (himself and others) _____

e. Risk-taker (versus conservative) _____

f. Human relations skills _____

g. Flexibility _____

h. Other (specify)_____) _____

INTERVIEWEE RESPONSE WORK SHEET

A. BUSINESS ADMINISTRATION _____

B. FINANCIAL MANAGEMENT _____

C. INDUSTRIAL MANAGEMENT _____

D. PERSONNEL MANAGEMENT _____

E. SYSTEMS MANAGEMENT _____

F. ELECTRICAL ENGINEERING _____

G. MECHANICAL ENGINEERING _____

H. OPERATIONS RESEARCH _____

I. MATHEMATICS _____

J. SCIENCE (SPECIFIC FIELD_____)

K. ENGINEERING (SPECIFIC FIELD_____) _____

L. OTHER (SPECIFIC FIELD_____) _____

A. COMMAND/OPERATIONAL EXPERIENCE _____

B. HEADQUARTERS, AIR STAFF, NUMBERED AF _____

C. ENGINEERING/LABORATORY EXPERIENCE _____

D. SYSTEM PROGRAM MANAGEMENT EXPERIENCE _____

E. OTHER (SPECIFY) _____

A. COMMUNICATIVE SKILL _____

B. DECISION MAKING ABILITY (DECISIVENESS) _____

C. IMAGINATION, CREATIVITY _____

D. MOTIVATION, AGGRESSIVENESS (HIMSELF AND OTHERS) _____

E. RISK-TAKER (VS CONSERVATIVE) _____

F. HUMAN RELATIONS SKILLS _____

G. FLEXIBILITY _____

H. OTHER (SPECIFY_____) _____

APPENDIX B

ORGANIZATIONAL POSITIONS INTERVIEWED

Aeronautical Systems Division (ASD)

Deputy for Reconnaissance/Strike/Electronic Warfare

Deputy for Systems

Deputy for SRAM (AGM-69)

Deputy for SCAD (AGM-86)

Deputy for Sub-Systems

Deputy for F-15

Deputy for B-1

Deputy for C-5A

Deputy for A-10

Deputy for Prototype

Electronic Systems Division (ESD)

Deputy for Airborne Command Post

Deputy for AWACS

Deputy for Communications/Navigation Systems

Deputy for Planning/Technology/Standardization

Deputy for Surveillance Control Systems

Deputy for Iranian Programs

Space and Missile Systems Organization (SAMSO)

Deputy for Development Plans

Deputy for Technology

Deputy for Launch Vehicles

Deputy for Special Defense Systems

Deputy for Special Communication Systems

Deputy for Reentry Systems

Deputy for Minuteman

Deputy for Defense Satellite Systems

APPENDIX C

PRODUCT CENTER BIAS CHECK

APPENDIX C

BIAS CHECK WITH PRODUCT CENTERS

The Spearman rank correlation method was used tc measure the level of agreement between each of the three product centers, ASD, ESD, and SAMSO within each stage of the acquisition life cycle. The results showed that there was a considerable level of agreement among Product centers for each qualification in each stage of the life cycle, with one exception. The level of agreement between ESD and ASD, and between ESD and SAMSO was very low in the young stage of the acquisition life cycle for managerial trait qualifications. ESD interviewees differed with respect to their ASD and SAMSO counterparts in that they placed:

1. Less emphasis on motivation/aggressiveness in an SPD for the young stage.

2. More emphasis on imagination/creativity in an SPD for the young stage.

3. Less emphasis on decision-making in an SPD for the young stage.

The authors decided to eliminate the ESD computations from the data base to evaluate its effects on the measurement of agreement previously computed. The elimination of this data did not change the initial conclusions, and in fact,

actually showed a higher level of agreement between stages of the life cycle, as shown below:

Data Base of Managerial Traits	Young versus Mature	Young versus Old	Mature versus Old
ESD Included	.86	.78	.99
ESD Removed	.96	.96	1.00

Hence, inclusion of the ESD interviewees' responses in the data base provided no reason to reject the null hypothesis.

APPENDIX D

SPEARMAN'S COMPUTATIONS

This appendix outlines in detail the data and steps taken to compute r_s (10:841-845;19:202-213) for each stage versus stage comparison. The following steps were accomplished in order:

1. Rank orderings by interviewees.
2. Composite totals and overall rank orderings.
3. Computation of D_i^2 for each characteristic for stage versus stage comparison.
4. Computation of r_s.

The rank orderings of preferences are indicated for each interviewee. Each interviewee was assigned a number along with a letter identifying his product center, i.e., (A) ASD, one through ten; (E) ESD, one through six; and (S) SAMSO, one through eight. In descending order of preference, rankings are from the highest number down to the lowest. In case of ties, mean ranks were assigned to sets of ties; that is, when two or more objects were tied in order, each was assigned the mean of the ranks they would have otherwise occupied. Data has been summarized in the three categories for each stage in the life cycle, as follows:

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	E1	E2	E3	E4	E5	E6	S1	S2	S3	S4	S5	S6	S7	S8
EDUCATION																								
BUSINESS ADMINISTRATION		1		1	2	2		2	2	1			2			1			3					1
FINANCIAL MANAGEMENT		2	2	2	1	1		1	1	2	1	1	1	1	1			1	4	1	2	2	2	
INDUSTRIAL MANAGEMENT	2		1									2				2		3		2		1	1	
PERSONNEL MANAGEMENT											2			2	2									
SYSTEMS MANAGEMENT	3	3	3	3	3	3		3	3	3	3	3	3	3		3			5	3	5		3	5
ELECTRICAL ENGINEERING	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	2	4.5	4	5	5	3
MECHANICAL ENGINEERING	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	1	4.5	3	4	4	2
OPERATIONS RESEARCH	1														3			2			1	3		4
EXPERIENCE																								
COMMAND/OPERATIONAL	1	1	1	2	1	1		1	2	2	1	2	1	1	3	3		1	1	1	2	1	1	1
HQ/[illegible]	2	2	2	1	2	3		4	3	1	2	3	2	2	1	1		2	2	2	1	4	2	2
ENGINEERING/LABORATORY	4	4	3	4	4	2		3	1	3	4	1	4	4	4	4		4	4	4	3	2	4	3
SYSTEMS PROGRAM MGMT	3	3	4	3	3	4		2	4	4	3	4	3	3	2	2		3	3	3	4	3	3	4
MANAGERIAL TRAITS																								
COMMUNICATIONS SKILLS	4	4	5	4	4	3		1	2	3	4	3	3	4	3	3		3	4	1	3	1	4	3
DECISION MAKING ABILITY	5	5	4	5	5	5		4	4	4		5			2	2		5	5	5	5	5		5
INNOVATION/CREATIVITY	2		1	2	1	4		3		5	5	4	5	5	5	5			1		1	4	1	2
MOTIVATION/AGGRESSIVE	3	3	2	3	3			2	5		1		2	1		4		2	3	3	4	3	3	1
RISK TAKER									1						1							2		
HUMAN RELATIONS	1	2	3	1	2	1			3	2	3	2	4	3				1	2	4	2		2	4
FLEXIBILITY		1				2				1	2	1	1	2	4	1		4		2				

Rank Ordering by Interviewees in the Young Stage

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	E1	E2	E3	E4	E5	E6	S1	S2	S3	S4	S5	S6	S7	S8
EDUCATION																								
BUSINESS ADMINISTRATION	2	3	3	4	2	4	4	4	4	3	1	2	4		2	5			4		2			4
FINANCIAL MANAGEMENT	4	4	4	3	4	3	3		3	4	4	4	3	4		3	1	5	1	4	3	4	4	1
INDUSTRIAL MANAGEMENT	3	2	2	1	1	2	2	1	2	2		3	2			2		3	3	3	4		1	3
PERSONNEL MANAGEMENT						1	1						1	1	1				2					2
SYSTEMS MANAGEMENT	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	4	4		5	5	5	5	5	5
ELECTRICAL ENGINEERING								2.5			2.5			2.5	4.5		2.5	2		2		2	3	
MECHANICAL ENGINEERING								2.5			2.5			2.5	4.5		2.5	1		1		1	2	
OPERATIONS RESEARCH	1	1	1	2	3				1	1		1				1	5	4			1	3		
EXPERIENCE																								
COMMAND/OPERATIONAL	2	2	2	1	2	1	2	1	2	2	1	2	2	1	2	2	2	1	1	3	2	2	3	1
HQ/AIR STAFF	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	3	1	2	3	2	3	4	2	3
PROFESSIONAL/LABORATORY	1	1	*	2	1	2	1	2	1	1	2	1	3	2	4	1	3	3	2	1	1	1	1	2
SYSTEMS ACQUISITION/MGMT	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	3	4	4
MANAGERIAL TRAITS																								
COMMUNICATIONS SKILLS	4	5	4	5	4	3	4	4	4	4	4	5	5	1	5	1	3	1	4	1	4	1	4	4
DECISION MAKING ABILITY	5	4	5	4	5	5	5	5	5	5		4	4	3	4	3	5	5	3	3	3	5	5	5
IMAGINATION/CREATIVITY	1			1	1	*	3	1			5		1			4			1		1	3	1	1
MOTIVATION/AGGRESSIVE	2	2	2	3	2		2	3	3	3	1	1		4	1	2	2	2	2	4	5	4	2	2
RISK TAKER			1						1	2				2			1					2		
HUMAN RELATIONS	3	3	3	2	3	1	1	2	2	1	3	3	3	3	3	5	4	3	3	5	2		3	3
FLEXIBILITY		1				2					2	2	2		2			4		2				

Rank Ordering by Interviewees in the Mature Stage

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	E1	E2	E3	E4	E5	E6	S1	S2	S3	S4	S5	S6	S7	S8
EDUCATION																								
BUSINESS ADMINISTRATION		3	3	4	2	4	4	4	2	3	1	2	2	1		5			3		2.5			2
FINANCIAL MANAGEMENT		4	4	3	4	3	3	2	3	4	4	4	3	4	1	1		5	4	4	2.5	4	4	3
INDUSTRIAL MANAGEMENT		2	2	1	1	2	2	3	4	2	2	3	4	2	2	2		4	2	3	4		3	4
PERSONNEL MANAGEMENT						1	1				3		1	3					1					1
SYSTEMS MANAGEMENT		5	5	5	5	5	5	5	5	5	5	5	5	5	5	4			5	5	5	5	5	5
ELECTRICAL ENGINEERING															3.5			2		2		2	2	
MECHANICAL ENGINEERING															3.5					1		1	1	
OPERATIONS RESEARCH		1	1	2	3			1	1	1		1				3		3			1	3		
EXPERIENCE																								
COMMAND/OPERATIONAL		2	2	3	3	1	2	1	2	2	2	2	2	2	2	2		1	2	3	3	2	3	2
HQ/AIR STAFF		3	3	2	2	3	3	3	3	3	3	3	3	3	1	3		2	3	2	2	4	2	3
ENGINEERING/LABORATORY		1	1	1	1	2	1	2	1	1	1	1	1	1	3	1		3	1	1	1	1	1	1
SYSTEMS PROGRAM MGMT		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		4	4	4	4	3	4	4
MANAGERIAL TRAITS																								
COMMUNICATIONS SKILLS		5	5	5	5	3	4	4	4	4	5	5	4	5	4	2		3	4	3	4	1	4	3
DECISION MAKING ABILITY		4	4	4	4	5	5	5	5	5	4	4	3	4	5	3		5	5	4	5	5	5	5
IMAGINATION/CREATIVITY				1	2	4	3	2				1							1		1	3	1	
MOTIVATION/AGGRESSIVE		2	2	3	1		2	3	3	2	1		1	1	3	5		1	2	1	3	4	2	2
RISK TAKER			1						1	3												2		
HUMAN RELATIONS		3	3	2	3	1	1	2	2	1	3	3	5	3	2	4		4	3	5	2		3	4
FLEXIBILITY		1				2					2	2	2	2	1	1		2		2				1

Rank Ordering by Interviewees in the Qld Stage

Composite total values were then computed for each stage of the life cycle. Individual rank orderings were totalled for each characteristic of each category. The same computations were made for each stage in the life cycle. Totals for each characteristic along with the overall ranking within that category are indicated by the following:

Education	Young Stage		Mature Stage		Old Stage	
	Total	Rank	Total	Rank	Total	Rank
Business Administration	18	4	57	6	47.5	5
Financial Management	29	5	73	7	73.5	7
Industrial Management	14	2.5	42	5	54	6
Personnel Management	6	1	9	1	11	2
Systems Management	63	6	111	8	104	8
Electrical Engineering	95.5	8	23.5	3	11.5	3
Mechanical Engineering	90.5	7	19.5	2	7.5	1
Operations Research	14	2.5	25	4	21	4

Experience	Young Stage		Mature Stage		Old Stage	
	Total	Rank	Total	Rank	Total	Rank
Command/ Operational	31	1	42	2	46	2
Hq./Air Staff/ NAF	46	2	64	3	59	3
Engineer/ Laboratory	73	4	40	1	28	1
System Program Management	70	3	94	4	87	4
Managerial Traits						
Communication Skills	69	6	84	6	86	6
Decision Making Ability	85	7	104	7	98	7
Imagination/ Creativity	56	5	28	3	18	2.5
Motivation/ Aggressive	48	4	54	4	44	4
Risk Taker	4	1	9	1	7	1
Human Relations	42	3	64	5	59	5
Flexibility	26	2	17	2	18	2.5

Stage versus stage comparisons were then made of overall rank orderings. A D_i^2 was computed for the rank difference for each characteristic. For instance, in the young stage Business Administration was ranked fourth; in the mature stage, it was ranked sixth. Therefore, the D_i was 2. The D_i values were then squared. Resulting values were summed as indicated below:

Education	Young versus Mature		Young versus Old		Mature versus Old	
	D_i	D_i^2	D_i	D_i^2	D_i	D_i^2
Business Administration	2	4	1	1	1	1
Financial Management	2	4	2	4	0	0
Industrial Management	2.5	6.25	3.5	12.25	1	1
Personnel Management	0	0	1	1	1	1
Systems Management	2	4	2	4	0	0
Electrical Engineering	5	25	5	25	0	0
Mechanical Engineering	5	25	6	36	1	1
Operations Research	1.5	2.25	1.5	2.25	0	0
$\sum D_i^2$		70.5		85.5		4
Experience						
Command/Operational	1	1	1	1	0	0
Hq./Air Staff/NAF	1	1	1	1	0	0
Engineer/Laboratory	3	9	3	9	0	0
System Program Mgt.	1	1	1	1	0	0
$\sum D_i^2$		12		12		0

Managerial Traits	Young versus Mature		Young versus Old		Mature versus Old	
	D_i	D_i^2	D_i	D_i^2	D_i	D_i^2
Communication Skills	0	0	0	0	0	0
Decision Making Ability	0	0	0	0	0	0
Imagination/Creativity	2	4	2.5	6.25	.5	.25
Motivation/Aggressive	0	0	0	0	0	0
Risk Taker	0	0	0	0	0	0
Human Relations	2	4	2	4	0	0
Flexibility	0	0	.5	.25	.5	.25
$\sum D_i^2$		8		10.5		.5

The following formula was used to compute r_s:

$$r_s = 1 - \left[\frac{6 \sum_{i=1}^{N} D_i^2}{N^3 - N} \right]$$

(19:204),

where N was the number of characteristics in each category, and D_i^2 as computed previously. For example, in considering education in young versus mature, D_i^2 is 70.5 and N is eight. Therefore, computations are:

$$r_s = 1 - \left[\frac{6(70.5)}{(8)^3 - 8}\right]$$

$$= .16$$

All other computations are carried out in the same manner. The resultant r_s values are:

Category	Young versus Mature	Young versus Old	Mature versus Old
Education	.16	-.02	.95
Experience	-.20	-.20	1.00
Managerial Traits	.86	.78	.99

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AUTHOR BIOGRAPHICAL SKETCHES

BIOGRAPHICAL SKETCH

Major Smythe entered active duty in November, 1958 and received a commission in the Air Force upon completion of Navigator training at Harlingen AFB, Texas in December 1959. He attended the Electronic Warfare Training School at Keesler AFB, Mississippi, and subsequently served tours as a B-52 Electronic Warfare Officer at bases in California, New Mexico, Texas, and North Dakota. His most recent assignment was B-52 Electronic Warfare Officer Flightline Instructor/Evaluator at Castle AFB, California. His assignment after graduation is to Osan Air Base, Korea, as an Emergency Actions Controller.

BIOGRAPHICAL SKETCH

Captain McMullan entered active duty in June 1960. He was an enlisted member for nine years assigned duty in aircraft maintenance in Illinois, Delaware and Guam. Under the sponsorship of the Airman Education and Commissioning Program (AECP) he attended Indiana University graduating in 1969 with a B.S. in Industrial Management and a commission in the Air Force. After serving a tour as Range Logistics Officer for the Space and Missile Test Center (SAMTEC) Vandenberg AFB, California he was transferred to the Short Range Attack Missile (SRAM) SPO at Wright-Patterson AFB, Ohio as the Test and Deployment Logistics Officer. Upon graduation Captain McMullan's assignment is to the 388th Tactical Fighter Wing, Korat AFB, Thailand as the Wing Logistics Officer.